Stroke

ADVANCES IN STROKE

Advances in Diagnosis and Imaging 2025: Benchmarking Reporting Approach for Imaging in Neurological Studies

David S. Liebeskind, MD; Joanna M. Wardlaw, MD

The past year has demonstrated a shift in the stroke imaging landscape, where the greatest challenges have emerged not from hardware limitations or lack of innovation but from methodological inconsistencies in the published studies. Journals have increasingly featured studies on stroke imaging that omit critical details about imaging definitions, metrics, and the use of independent core labs. For example, some studies describe ischemic core volumes or perfusion thresholds but fail to explain how these were defined or validated. In the context of large-core ischemic stroke trials, different methodologies for defining ischemic core and infarct patterns have been used, yet details are often missing. This key problem was pointed out 18 years ago to see that such a lack of transparency continues to undermine the reproducibility of results and their applicability to clinical practice is not justifiable on any level.[1,2]

Adding to these challenges is the considerable geographic variability in stroke imaging and treatment protocols. Thrombolysis decisions, use of perfusion imaging, and definitions of successful reperfusion based on the expanded Treatment in Cerebral Infarction (eTICI) scale vary widely across institutions and regions.[3] Some centers prioritize noncontrast CT for rapid assessment, whereas others use multimodal magnetic resonance imaging–based workflows. Without standardized reporting, it becomes difficult to compare outcomes between studies, especially in multicenter or international trials. Importantly, there should be no differences between the methods actually used in a study or trial and the methods described in published reports or regulatory submissions. Such alignment ensures consistency and credibility, particularly for drug, device, or procedural technique approvals. The BRAINS guideline (Benchmarking Reporting Approach for Imaging in Neurological Studies) gives a specific imaging focus to STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology) and aims to address these domain gaps by providing a structured checklist to ensure uniformity in reporting, enabling meaningful comparisons and advancing clinical translation (full list of reporting guidelines and descriptions of why and how to use these will be made available on the Equator Network; www.equator-network.org).

GRAY, WHITE, AND METHODS MATTER

The reporting inadequacies in acute stroke imaging studies undermine the reliability of findings and their application in clinical practice. For instance, studies on ischemic core definition using the Alberta Stroke Program Early CT Score often fail to provide specifics on how scores were determined, including whether scoring was performed by a neuroradiologist, neurologist, or through automated software.[4] Furthermore, the role of imaging protocols, the quality of images, and the use of independent core labs are frequently omitted. Without these details, it is challenging to evaluate the validity of findings or apply them in clinical settings.

Advances in imaging modalities—such as multimodal CT, magnetic resonance imaging, and advanced

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Correspondence to: David S. Liebeskind, MD, Neurovascular Imaging Research Core, University of California, Los Angeles, 635 Charles E Young Dr S, Ste 225, Los Angeles, CA 90095. Email davidliebeskind@yahoo.com
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perfusion imaging—have provided powerful tools to detect ischemia and vascular pathologies. However, their inconsistent application across studies creates a significant barrier to progress. Multimodal CT, for example, is widely used to assess collateral blood flow, infarct patterns, and clot perviousness, but studies often fail to detail acquisition protocols or thresholds used in analysis.

Beyond acquisition methods, postprocessing techniques and the criteria used to define ischemic core vary significantly. Some centers apply relative cerebral blood flow thresholds of <30% to define core infarction, whereas others use mismatch ratios based on time-to-maximum delays. The substantial differences in apparent tissue viability that result from use of different definitions will result in wide variation in treatment decisions that deny some patients the benefit of thrombectomy or thrombolysis.[1,2] Similarly, eTICI-based reperfusion assessment is often inconsistently reported, with some studies grouping eTICI 2b50 to 3 as successful reperfusion, whereas others differentiate them based on distal perfusion characteristics. These inconsistencies further emphasize the need for standardized reporting through the BRAINS checklist. Notably, alignment between clinical trial methods and regulatory submissions is essential for ensuring transparency and fostering trust in reported outcomes.

Moreover, the expertise of imaging readers plays a pivotal role in the quality of interpretations. Studies should explicitly state the number of imaging readers, their level of training, prior performance metrics, and whether adjudication was performed via consensus or independent scoring. These factors significantly affect the consistency and reliability of reported findings, yet they are frequently omitted. Documentation of interrater variability and measures to minimize bias, such as standardized training protocols, should be included to enhance reproducibility across studies.

STANDARDS, GROUND TRUTH, AND PERFORMANCE METRICS

Recent publications emphasize the importance of detailed imaging metrics in assessing treatment outcomes, particularly in reperfusion therapies. However, these studies often lack comprehensive descriptions of how metrics such as infarct volume, collateral blood flow, or blood-brain barrier integrity are quantified. This is particularly concerning in studies employing advanced imaging modalities, as the absence of standardized ground truth or performance metrics introduces variability in interpretations.

For example, large-core ischemic stroke trials have reported highly variable methods for measuring infarct volume and assessing collateral perfusion. Some studies use manual measurements, whereas others rely on automated software, yet details on validation and reproducibility are rarely provided. Similarly, imaging of reperfusion injury—including hemorrhagic transformation and blood-brain barrier disruption—is often described in qualitative terms, with no standardized criteria for classification.[5]

In addition, geographic variability further complicates the assessment of reperfusion success. Some stroke centers use eTICI grading extensively, whereas others prefer noninvasive assessments based on multimodal CT or magnetic resonance imaging. In certain regions, the use of extended time windows for thrombectomy is driven by perfusion-based selection, whereas others rely more heavily on clinical-core mismatch criteria. The BRAINS guideline proposes the adoption of uniform standards for reporting these measures, ensuring consistency across studies and institutions. Moreover, regulatory applications must reflect the actual methodologies used in trials, ensuring that submissions are consistent with the published literature. Furthermore, all studies should report details regarding the number of readers, the method of adjudication via consensus, the expertise and prior history of each reader, and performance metrics such as interrater reliability. Training background should also be documented to provide transparency and allow for comparability between studies.

Beyond reader expertise, performance metrics such as the time to image acquisition, interpretation times, and software validation processes should be disclosed. These metrics are critical for evaluating the scalability of imaging techniques in clinical workflows and for regulatory approvals. Inclusion of these details in both publications and regulatory submissions will ensure that imaging innovations can be effectively translated into practice.

DATA SHARING TO REPORTING GUIDELINES

The absence of detailed reporting and data sharing in stroke imaging studies represents a significant barrier to progress. Many studies fail to disclose critical imaging definitions, interpretation methodologies, or use of core labs, limiting their clinical applicability. For example, studies often describe ischemic core volumes or Alberta Stroke Program Early CT Scores but do not provide data on interrater reliability, core lab adjudication, or specific thresholds used in the analysis. These omissions make it difficult for clinicians and researchers to replicate findings or apply them in practice.

To address these issues, we propose the BRAINS guideline. This framework would mandate comprehensive reporting of imaging protocols, independent validation of

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metrics, and full disclosure of data analysis methods. Key components of the BRAINS checklist would include the following:

1. Detailed descriptions of imaging acquisition protocols and parameters.
2. Use of independent core labs for adjudication of imaging metrics.
3. Specific definitions of ischemic core, infarct patterns, and collateral perfusion.
4. Inclusion of imaging reader details, training backgrounds, and performance metrics.
5. Documentation of interrater reliability and validation processes.
6. Standardized reporting of eTICI scores and other reperfusion measures.
7. Full transparency in data analysis methods, including software and thresholds used.
8. Assurance that methods reported in publications align with those used in regulatory submissions.

By adopting the BRAINS guideline as a required checklist for imaging studies submitted for publication, journals can ensure that research findings are rigorous, reproducible, and clinically applicable. Regulatory agencies would similarly benefit from such standardized reporting, reducing ambiguities in submissions for drug, device, or technique approvals, both in the United States and internationally. This alignment will also promote global collaboration, enabling comparisons across studies and fostering innovations that can improve patient outcomes. The launch of the BRAINS guideline reflects the minimal requirements for acute stroke trials, yet there is a similarly critical need to develop expanded standards for reporting imaging methodology in other types of neurological studies beyond trials and other neurovascular disorders. For example, include how readers differentiate and define acute versus subacute versus chronic infarcts on CT and magnetic resonance imaging, how subcortical lesions are described or quantified, how infarct location of infarct topography is delineated, or how intracranial atherosclerotic lesions are characterized. These detailed variables cannot replace the sharing of imaging data, but at the least, they entail minimal standards warranted in any form of neuroimaging research and the resultant publications.

CONCLUSIONS

The most significant advances in stroke imaging over the past year have been in recognizing and addressing methodological shortcomings in research reporting. The proliferation of poorly detailed studies—particularly in large-core ischemic stroke trials—highlights the urgent need for improved standards, a shortcoming that was pointed out almost 20 years ago and should have been fixed long before. Without transparent and consistent reporting practices, the potential impact of imaging innovations will remain limited.

The proposed BRAINS reporting guideline offers a pathway to enhance the quality and impact of stroke imaging research. Journals should adopt the BRAINS guideline as a mandatory requirement for all imaging studies submitted for publication, ensuring greater transparency, reproducibility, and clinical utility in stroke imaging research. Furthermore, consistency between trial methodologies and regulatory submissions is paramount to fostering trust, ensuring credibility, and facilitating the translation of research into clinical practice.

ARTICLE INFORMATION

Affiliations

Neurovascular Imaging Research Core, University of California, Los Angeles (D.S.L.). Centre for Clinical Brain Sciences, Edinburgh Imaging and UK Dementia Research Institute, University of Edinburgh (J.M.W.).

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